Section name

Mark 5 Disk Drive Performance and Reliability

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Abstract.   This paper shows how the write and read speed of a Mark 5 disk pack can be limited by the disk drive itself, the ATA data bus, or the StreamStor board. It also presents some data on disk drive reliability.

1. Disk Drive Performance

The performance of the Mark 5 VLBI data recording system is limited by three factors: 1) the disk drive, 2) the data bus, and 3) the StreamStor disk controller. This paper examines each of these limits and demonstrates each of them with measurements showing how the write and read data rates depend on the position of the write and read pointers. In all of the data presented here, the data rates (Mb/s) are 1-minute averages for the slowest bus in the pack, multiplied by the number of buses in the pack.

Figure 1 shows how the write rate is limited by the disk itself. It shows that for this modern disk, the speed drops from more than 500 Mb/s at the beginning to less than 256 Mb/s at the end. Mb/s, and the 66 MB/s per bus limit of the XF2 StreamStor disk subsystem.

Figure 2 shows how the data rate can be limited by the 66 MB/s (528 Mb/s) data rate of the PATA bus used by the XF2 StreamStor board used in the Mark 5A and Mark 5B. Because of some overhead in reading and writing the disk drives, the data rate does not quite reach the bus speed of 528 Mb/s. And it can be seen that the speed of the disk drives slows down near the end. The Amazon StreamStor board used in the Mark 5B+ clocks the PATA bus at 100 MB/s and increases this bus speed limit from 528 Mb/s to 800 Mb/s.

The data rate of an 8-pack in a Mark 5A or Mark 5B recorder is limited by the XF2 StreamStor board to 1775 Mb/s read and 1715 Mb/s write. The data rate goes up slightly to 1845 Mb/s for reading and writing, when using two 8-packs in non-bank mode.

With the Amazon board in the Mark 5B+ recorder, the maximum data rate increases to 3090 Mb/s read and 2980 Mb/s write, until limited by the speed of the disk drives, as shown in Figure 3. This data rate is near the maximum data

rate for four 100 MB/s PATA buses or 3200 Mb/s. Note that the rate stays above 2 Gb/s until the module is almost full. Note also that the rate shown in the figure is for the slowest of the 4 buses. In our testing and operations, an 8-pack module populated with modern disk drives 250-GB or larger can record reliably at 2048 Mb/s to the end.

When using two 8-packs in a Mark 5B+ in non-bank mode, the data rate almost doubles, to 5800 Mb/s for reading and 6070 Mb/s writing, until limited by the speed of the disk drives, as shown in figure 4. Note that this pair of modules stays above 4096 Mb/s until full, based on the slowest bus.

To summarize, the data rate of a Mark 5A or Mark 5B recorder with 8 or more disk drives is limited to about 1700 Mb/s by the XF2 StreamStor board. With the Amazon board in the Mark 5B+, most modern 8-packs can record reliably at 2048 Mb/s, and a pair of 8-packs can record at 4096 Mb/s in non-bank mode.

2. Reliability

For the last 5 years we have been keeping a record of every Mark 5 disk drive replaced at Haystack. About half of these disks were replaced under warranty by the disk drive manufacturer. Figure 2 shows the age distrbution of the failed disks. A few of these "failures" were disk drives that were too slow to support Mark 5 recording at 128 Mb/s/drive, but still passed the manufacturer's drive fitness test. Not counted in this analysis are disk drives that failed during initial testing or the first "conditioning" of the Mark 5 disk pack. This initial screening probably accounts for the low number of failures during the first 6 months.
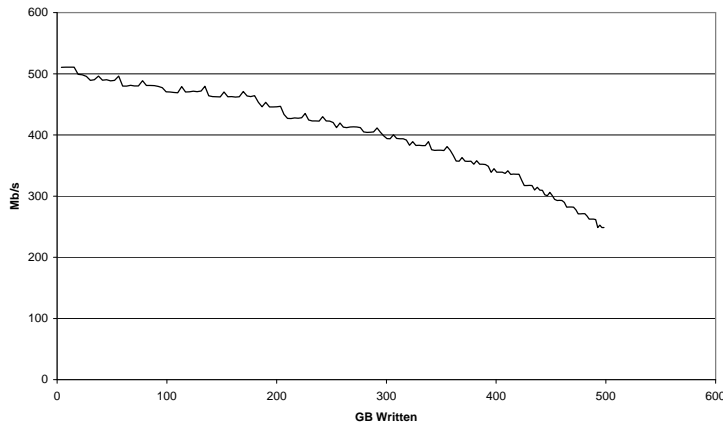

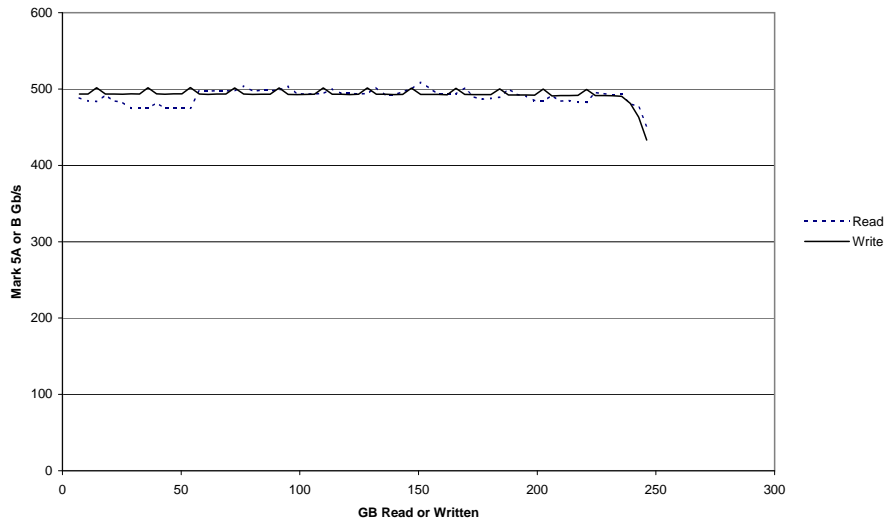Figure 1. Single Hitachi 500 GB disk drive.

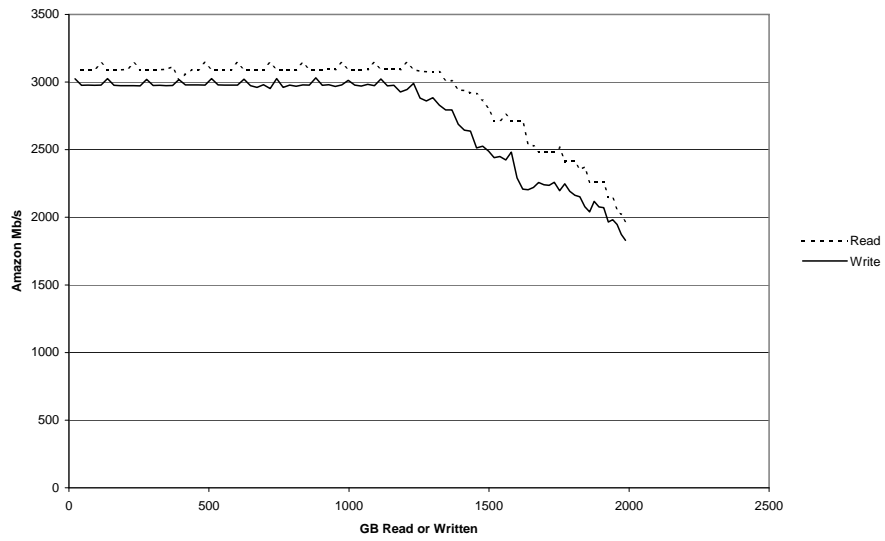Figure 2. Master-slave pair with Mark 5A or Mark 5B.

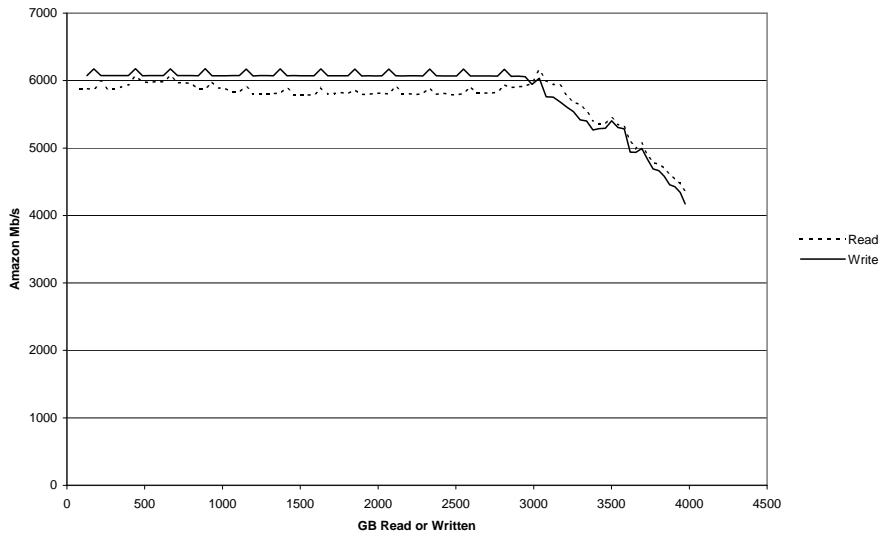Figure 3. Mark 5B+ performance with an 8-pack of 250-GB disk drives.
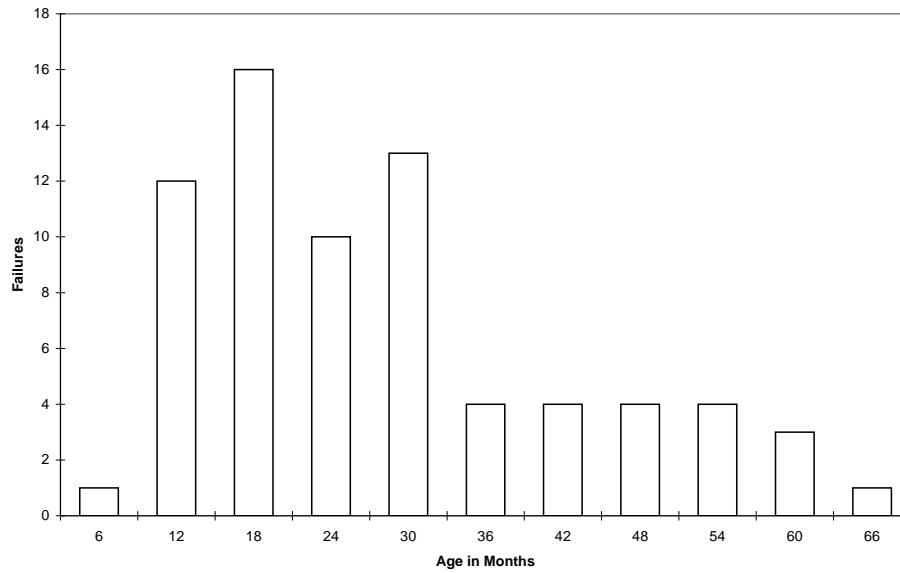
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Figure 4. Mark 5B+ performance with two 8-packs in non-bank mode.

Figure 5. Disk drive failures as a function of age.

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